

## DESCRIPTION

5 Tensioned End Structure of Prestressed-Concrete Structure  
and Method of Constructing Tensioned End of Prestressed-  
Concrete Structure

## Technical Field of the Invention:

10 The present invention relates to the structure of a tensioned end of a prestressed-concrete structure and also relates to a method of constructing the tensioned end. More particularly, the present invention relates to a technique wherein a transparent material is employed for a grout can to surely perform the construction of the tensioned end.

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## Background Art:

20 According to a conventional prestressed-concrete structure producing method (post-tensioning system), prestressing steel and a sheath covering it, together with reinforcing bars, are disposed in a form. Thereafter, concrete is placed in the form. After, the concrete has reached a predetermined strength, the prestressing steel is tensioned from both horizontal ends or either of them, and each end portion of the prestressing steel is anchored

25 with an anchoring device, thereby prestressing the concrete.

Thereafter, a grout is externally injected into the anchorage and its vicinities and also into the sheath at a

high pressure (0.5 to 1 MPa) to fill them for the purpose of preventing corrosion of the tensioned prestressing steel and for securing the prestressing steel in the sheath under tension and further for fixing the interior  
5 of the anchorage and its vicinities. At that time, a grout can is secured to the anchorage to cover the whole anchorage in a hermetically sealed state, and thereafter, the grout is injected from an outer communicating hole (grout hose fitting hole) to fill the inside of the grout  
10 can.

Japanese Patent Application Unexamined Publication (KOKAI) No. Hei 8-35331 discloses a method in which a metallic grout can is used. In this case, however, the inside of the grout can cannot be seen. Therefore, it is  
15 impossible to confirm the completeness of the filling of grout at the tensioned end portion, which is particularly important. Further, because the grout can is made of a metal, an electric potential difference is produced between the grout can and the prestressing steel or other  
20 different kind of metal. Consequently, a corrosive current flows, and this may cause corrosion of the prestressing steel.

Further, when the grout is injected into the grout can at a high pressure (0.5 to 1 MPa), if the grout can is  
25 in the shape of a cylinder with a flat bottom as illustrated in Japanese Patent Application Unexamined Publication (KOKAI) No. Hei 8-35331, the pressure of the injected grout is applied non-uniformly to the inner

surfaces of the grout can. This involves the danger that the grout can may be deformed and hence the grout may leak.

In the case of internal cable construction, the anchorage structure including the grout can and its  
5 vicinities is covered with post-placed concrete. If the adhesion between the post-placed concrete and the grout can is incomplete, it is impossible to attain the primary object, i.e. forming the anchorage and the post-placed concrete into one integral structure. In the case of  
10 external cable construction, the grout can is relatively large in size. Therefore, the conventional metallic grout can is heavy in weight and hence inconvenient to handle.

#### Disclosure of Invention:

15 As the result of conducting exhaustive studies to solve the above-described problems with the prior art, the present inventors succeeded in establishing a substantially perfect grouting technique and thus came to provide the present invention having the following  
20 arrangements.

(1) A tensioned end structure of a prestressed-concrete structure wherein a grout can that is installed over an anchorage in such a manner as to cover the whole anchorage is filled with a grout as a cement or non-cement anti-  
25 corrosive filler for anti-corrosive protection of a tendon member and an anchoring device, which is characterized in that the grout can is made of a transparent material.

(2) A tensioned end structure of a prestressed-concrete

structure as stated in the foregoing paragraph (1), which is characterized in that the transparent material constituting the grout can is at least one selected from the group consisting of polyethylenes and derivatives thereof, polypropylenes, polystyrenes, polycarbonates, polymethyl methacrylates, and polyvinyl chlorides.

(3) A tensioned end structure of a prestressed-concrete structure as stated in the foregoing paragraph (1) or (2), which is characterized in that the transparent material constituting the grout can consists essentially of an ionomer resin, wherein the ionomer resin is an  $\alpha$ -olefin- $\alpha$ ,  $\beta$ -unsaturated carboxylic acid copolymer having carboxyl groups neutralized with metal ions.

(4) A tensioned end structure of a prestressed-concrete structure as stated in any one of the foregoing paragraphs (1) to (3), which is characterized in that the grout can is a half-cut hollow spherical member having a ring-shaped rib at the upper edge thereof.

(5) A tensioned end structure of a prestressed-concrete structure as stated in any one of the foregoing paragraphs (1) to (3), which is characterized in that the grout can is a cylindrical member, one end of which is closed, the cylindrical member having a ring-shaped rib at the upper edge thereof and a half-cut hollow spherical portion at the bottom thereof.

(6) A tensioned end structure of a prestressed-concrete structure as stated in any one of the foregoing paragraphs (1) to (5), which is characterized in that the outer

surface of the grout can has been formed into an uneven surface so as to be easily adherable to post-placed concrete or mortar.

5 (7) A tensioned end structure of a prestressed-concrete structure as stated in any one of the foregoing paragraphs (1) to (6), which is characterized in that the grout can is made of an electrically insulating material.

10 (8) A method of constructing a tensioned end of a prestressed-concrete structure, which is characterized by installing a grout can made of a transparent material over an anchorage to cover the whole anchorage with the grout can, and fully filling the grout can with a grout as a cement or non-cement anti-corrosive filler for anti-corrosive protection of a tendon member and an anchoring  
15 device while visually observing the filling condition of the grout in the grout can from the outside.

(9) A method of constructing a tensioned end of a prestressed-concrete structure as stated in the foregoing paragraph (8), which is characterized in that the  
20 transparent material constituting the grout can is at least one selected from the group consisting of polyethylenes and derivatives thereof, polypropylenes, polystyrenes, polycarbonates, polymethyl methacrylates, and polyvinyl chlorides.

25 (10) A method of constructing a tensioned end of a prestressed-concrete structure as stated in the foregoing paragraph (8), which is characterized in that the transparent material constituting the grout can consists

essentially of an ionomer resin, wherein the ionomer resin is an  $\alpha$ -olefin- $\alpha$ ,  $\beta$ -unsaturated carboxylic acid copolymer having carboxyl groups neutralized with metal ions.

(11) A method of constructing a tensioned end of a  
5 prestressed-concrete structure as stated in any one of the foregoing paragraphs (8) to (10), which is characterized in that the grout can is a half-cut hollow spherical member having a ring-shaped rib at the upper edge thereof.

(12) A method of constructing a tensioned end of a  
10 prestressed-concrete structure as stated in any one of the foregoing paragraphs (8) to (10), which is characterized in that the grout can is a cylindrical member, one end of which is closed, the cylindrical member having a ring-shaped rib at the upper edge thereof and a half-cut hollow  
15 spherical portion at the bottom thereof.

(13) A method of constructing a tensioned end of a prestressed-concrete structure as stated in any one of the foregoing paragraphs (8) to (12), which is characterized in that the outer surface of the grout can has been formed  
20 into an uneven surface so as to be easily adherable to post-placed concrete or mortar.

(14) A method of constructing a tensioned end of a prestressed-concrete structure as stated in any one of the foregoing paragraphs (8) to (13), which is characterized  
25 in that the grout can is made of an electrically insulating material.

(15) A grout can made of a transparent material as stated in any one of the foregoing paragraphs (1) to (13), which

is used in a tensioned end structure of a prestressed-concrete structure or a production thereof.

Brief Description of the Drawings:

5            Fig. 1 is a sectional view of a tensioned end structure of a prestressed-concrete structure of an internal cable system according to Example 1 of the present invention.

10           Fig. 2 is a sectional view of a tensioned end structure of a prestressed-concrete structure of an external cable system according to Example 2 of the present invention.

15           Fig. 3 is a sectional view of a tensioned end structure of a prestressed-concrete structure of an external cable system according to Example 3 of the present invention.

            Fig. 4 is a plan view and a sectional view of a grout can in Fig. 1.

20           Fig. 5 is a plan view and a sectional view of a grout can in Fig. 2.

            Fig. 6 is a plan view and a sectional view of a grout can in Fig. 3.

Explanation of Reference Signs:

25    1: prestressing steel cable  
      2: sheath  
      3: socket of anchoring device  
      4: plug of anchoring device

- 5, 5', 5'': grout can
- 5a, 5a', 5a'': rib of grout can
- 5b, 5b', 5b'': grout discharge pipe
- 5c, 5c': grout discharge pipe
- 5 5d: bolt insertion hole
- 5e: grout injection pipe
- 6: grout hose
- 7: packing
- 8: grout can securing bolt
- 10 9: spiral reinforcement
- 10: differential-diameter joint
- 10a: grout injection pipe of differential-diameter joint
- 11: anchor plate
- 12: anchor head
- 15 13: wedge
- 14: inner trumpet
- 15: outer trumpet
- 16: caulking ring
- 17: resin sheath
- 20 18: steel pipe
- 50: half-cut hollow spherical portion
- 51: cylindrical portion
- C: concrete
- G: grout
- 25 M: post-placed concrete or mortar
- V: void

Best Mode for Carrying Out the Invention:

Embodiments of the present invention will be described below with reference to the accompanying drawings.

Fig. 1 is a sectional view of a tensioned end structure of a prestressed-concrete structure of an internal cable system according to Example 1 of the present invention. Fig. 2 is a sectional view of a tensioned end structure of a prestressed-concrete structure of an external cable system according to Example 2 of the present invention. Fig. 3 is a sectional view of a tensioned end structure of a prestressed-concrete structure of an external cable system according to Example 3 of the present invention.

Fig. 4 is a plan view and a sectional view of a grout can in Fig. 1. Fig. 5 is a plan view and a sectional view of a grout can in Fig. 2. Fig. 6 is a plan view and a sectional view of a grout can in Fig. 3.

In the drawing: C denotes concrete; G denotes grout; M denotes post-placed concrete or mortar; 1 denotes prestressing steel cables; 2 denotes a sheath; 3 denotes a socket of anchoring device; 4 denotes a plug of anchoring device; 5, 5', 5'' denote grout cans; 5a, 5a', 5a'' denote ribs of grout cans; 5b, 5b', 5b'' and 5c, 5c' denote grout discharge pipes; 5d, 5d', 5d'' denote bolt insertion holes; 5e denotes a grout injection pipe; 6 denotes a grout hose; 7 denotes a packing; 8 denotes grout can securing bolts; 9 denotes spiral reinforcement; 10 denotes a differential-diameter joint; 10a denotes a grout injection pipe of

differential-diameter joint; 11 denotes an anchor plate; 12 denotes an anchor head; 13 denotes wedges; 14 denotes an inner trumpet; 15 denotes an outer trumpet; 16 denotes a caulking ring; 17 denotes a resin sheath; and 18 denotes a steel pipe.

First, as shown in Fig. 1, which is a sectional explanatory view of a tensioned end structure in the vicinity of an anchorage of an internal cable system, end portions of prestressing steel cables 1 are anchored under tension by using a socket 3 and a plug 4, which constitute an anchoring device, buried in an end portion of concrete C. A sheath 2 is connected to a projecting portion 3a of the socket 3 through a differential-diameter joint 10 to enclose a bundle of 6 to 12 prestressing steel cables 1. A grout can 5 is secured over the anchorage of the tensioned end with grout can securing bolts 8.

It should be noted that as the grout can those as shown in Figs. 4 to 6 can be used.

The grout can 5 shown in Figs. 4(a) and (b) is a half-cut hollow spherical member having a ring-shaped rib 5a at the upper edge thereof. The grout can 5' shown in Figs. 5(a) and (b) is a cylindrical member, one end of which is closed. The cylindrical member has a ring-shaped rib 5a' at the upper edge thereof and a half-cut hollow spherical portion 50 at the bottom thereof. The grout can 5" shown in Figs. 6(a) and (b) is a cylindrical member, one end of which is closed. The cylindrical member has a ring-shaped rib 5a" at the upper edge thereof and a

slightly curved bottom portion.

As shown in Figs. 1 and 4, the belly portion of the grout can 5 is provided with connecting openings, and grout discharge pipes 5b and 5c are attached to the  
5 connecting openings to fit grout hoses 6 thereto, respectively.

As shown in Fig. 1, grout G is introduced into the sheath 2 at a high pressure (0.5 to 1 MPa) from a grout injection pipe 10a of the differential-diameter joint to  
10 fill the grout can 5 through through-holes (not shown) provided in the plug 4 in the anchorage. Excess grout is discharged to the outside through the grout discharge pipes 5b and 5c and the grout hoses 6.

At this time, because the grout can 5 is made of a  
15 transparent material, the filling condition of the grout can be visually observed easily from the outside, and it is possible to readily find any void portion left unfilled in the inner wall of the grout can 5. Therefore, if such a void portion is found, additional grouting is carried out  
20 to refill it, thereby attaining a completely filled condition.

It should be noted that the grout G is a cement milk mixed with an admixture, e.g. a dispersing agent. Then, concrete or mortar M for post placement is placed and  
25 hardened by using a form so as to cover the surface of the concrete C in the vicinity of the anchorage and also cover the outer peripheral surface of the grout can 5.

It is preferable that the post-placed concrete or

mortar M should be a material identical or similar to the concrete C so as to be integrated with the latter.

Next, the construction of a tensioned end in the vicinity of an anchorage of an external cable system will be described. As shown in Fig. 2, which is a sectional view of a tensioned end structure in the vicinity of the anchorage, end portions of prestressing steel cables 1 are anchored under tension by using an anchor head 12 attached to the outer surface of an end portion of concrete C, together with wedges 13. An anchor plate 11 is embedded in the inner surface of the concrete C inside the anchor head 12.

Further, an outer trumpet 15, together with an inner trumpet 14 inserted therein, is installed in the vicinity of the anchorage. A steel pipe 18 is fitted into the forward end portion of the outer trumpet 15. The forward end portion of the inner trumpet 14 is fitted into a resin sheath 17. In addition, a caulking ring 16 is fitted around the outer peripheral surface of the overlap of the inner trumpet 14 and the resin sheath 17.

A bundle of 12 to 27 prestressing steel cables 1 is inserted to extend through the inner trumpet 14 and the resin sheath 17.

It should be noted that a grout can 5' is secured to the surface of the anchor plate 11 with grout can securing bolts 8.

The grout can 5' used in this case is, as shown in Fig. 5, a cylindrical member, one end of which is closed.

The cylindrical member has a ring-shaped rib 5a' at the upper edge thereof and a half-cut hollow spherical portion 50 at the bottom thereof. Because it has the cylindrical portion 51, the grout can 5' is correspondingly increased in height.

The belly portion of the grout can 5' is provided with connecting openings, and grout discharge pipes 5b' and 5c' are attached to the connecting openings to fit grout hoses 6 thereto, respectively.

As shown in Fig. 2, which is a sectional view of the anchorage and its vicinities, grout G is introduced into the grout can 5' at a high pressure (0.5 to 1 MPa) from the right-hand side through the sheath 17 to fill the grout can 5'.

The grout G is filled into the grout can 5' through through-holes (not shown) provided in the anchor head 12. Excess grout is discharged to the outside through the grout discharge pipes 5b' and 5c' and the grout hoses 6.

At this time, because the grout can 5' is made of a transparent material, the filling condition of the grout can be visually observed easily from the outside, and it is possible to readily find any void portion V left unfilled in the inner wall of the grout can 5'. Therefore, if such a void portion is found, additional grouting is carried out to refill it, thereby attaining a completely filled condition.

The term "transparent material for the grout can" as used in the present invention means a material that allows

the filling condition of grout G in the grout can and the presence of air bubbles, etc. to be visually checked from the outside of the grout can. It is possible to use any material that is transparent and mechanically strong to  
5 some extent, for example, synthetic resins, high-strength glass (including tempered glass coated with a transparent resin), and ceramics.

Particularly, a transparent synthetic resin material is preferably used. Because the material is required to  
10 exhibit pressure resistance (during grouting), impact resistance, and moderate flexibility and toughness (when the rib portion is bolted), it is particularly preferable to use an ionomer resin consisting essentially of an  $\alpha$ -olefin- $\alpha$ ,  $\beta$ -unsaturated carboxylic acid copolymer having  
15 carboxyl groups neutralized with metal ions, which is a polyethylene derivative.

The polyethylene derivative-base ionomer resin is prepared by copolymerization of ethylene with a small amount of (meth)acrylic acid metal salt, and also known as  
20 an ethylene-base ionomer (EBI). The ionomer resin is excellent in transparency and also excellent in pressure resistance, flexibility and toughness.

The above-described transparent materials are generally not electrically conductive (i.e. they are  
25 electrically insulative) and hence unlikely to cause a corrosive electric current. It should be noted that polyethylenes (or polyethylene derivative-base ionomer resins) are also preferable from the viewpoint that they

are free from leakage of harmful substances (e.g. environmental hormones) into the environment.

Further, in the present invention, the grout can is transparent and hence allows any portion left unfilled with grout to be visually recognized easily from the outside of the grout can. Therefore, if an unfilled portion is found after the grout has hardened, the grout can is bored to provide injection and discharge openings to regROUT the unfilled portion, thereby enabling the grout to be completely filled in the grout can (easiness and reliability of filling condition inspection and repairing).

#### Examples:

The present invention will be described below more specifically by way of examples.

#### Example 1:

This is an example of an internal cable system as shown in Fig. 1.

Molding of the grout can 5 was carried out by injection molding of a transparent resin using a mold having an inner surface processed into an embossing negative mold configuration in advance.

As a transparent electrically insulating resin material, "Himilan 1706" (trade name), which is a polyethylene derivative-base ionomer resin available from DuPont-Mitsui Polychemicals Co., Ltd., was used.

The grout can 5 has a configuration as shown in

Fig. 4. That is, the grout can 5 is a half-cut hollow spherical member having a ring-shaped rib 5a at the upper edge thereof. The inner diameter of the upper edge is 122 mm. The height of the grout can 5 is 60 mm. The rib width is 17 mm. Grout discharge pipes 5b and 5c (outer diameter: 19 mm) for fitting grout hoses are attached to the grout can 5, and grout hoses 6 are connected thereto.

First, as shown in Fig. 1, grout G, which is a cement milk mixed with an admixture, e.g. a dispersing agent, is introduced into the grout can 5 from the grout injection pipe 10a via the anchorage.

The thickness of the grout can 5 is 4 mm. The pressure resistance of the grout can 5 satisfies the required waterproof pressure of 1 MPa. Even when grout was introduced into the grout can 5 at a high pressure (0.5 to 1 MPa), neither deformation of the grout can 5 nor leakage of grout was observed.

The filling condition of the grout G was visually observable from the outside through the grout can 5. Thus, it was possible to easily confirm that neither air bubbles nor voids were present. It should be noted that the surface of the grout can 5 had been formed into an uneven surface (not shown) by embossing. Accordingly, the adhesion of the grout can 5 to post-placed concrete M was good (it was confirmed by a test of embedding the grout can into concrete, which was carried out separately, that the grout can did not separate from concrete after it had hardened).

Example 2:

This is an example of an external cable system as shown in Fig. 2. The grout can 5' was produced by  
5 injection molding using a material similar to that in Example 1.

The grout can 5' has a configuration as shown in Figs. 5(a) and (b). That is, the grout can 5' is a cylindrical member, one end of which is closed. The  
10 cylindrical member has a ring-shaped rib 5a' at the upper edge thereof and a half-cut hollow spherical portion 50 at the bottom thereof. The grout can 5' is provided with grout hose fitting pipes (outer diameter: 19 mm) 5b' and 5c', and grout hoses 6 are connected thereto.

15 The cylindrical inner diameter of the upper edge of the grout can 5' is 227 mm. The height of the grout can 5' is 204 mm. The rib width is 21.5 mm.

As shown in Fig. 2, which is a sectional view of the anchorage and its vicinities, grout G is introduced into  
20 the grout can 5' at a high pressure (0.5 to 1 MPa) from the right-hand side through the sheath 17 to fill the grout can 5'.

The grout G is filled into the grout can 5' through through-holes (not shown) provided in the anchor head 12.  
25 Excess grout is discharged to the outside through the grout discharge pipes 5b' and 5c' and the grout hoses 6.

It was visually observed from the outside during filling the grout that a void portion V remained in the

inner wall surface of the grout can 5'. Therefore, the grouting was continued. Consequently, the void portion V became invisible. Thus, it was perceived that the grout G had been completely filled.

5        It should be noted that the grout G used in this example was also a cement milk similar to that in Example 1.

10        The thickness of the grout can 5' is 4 mm. The pressure resistance of the grout can 5' satisfies the required waterproof pressure of 1 MPa. Even when grout was introduced into the grout can 5' at a high pressure (0.5 to 1 MPa), neither deformation of the grout can 5' nor leakage of grout was observed.

15        Further, the resin grout can 5' used in this example was light in weight in comparison to the conventional metallic grout can and hence easy to handle. Moreover, because the grout can 5' was not electrically conductive, there is no fear of the prestressing steel being corroded by a corrosive electric current that would otherwise be  
20        generated.

### Example 3:

25        This is an example of an external cable system as shown in Fig. 3. The grout can 5" was produced by injection molding using a material similar to that in Example 1.

As shown in Figs. 6(a) and (b), the grout can 5" is a cylindrical member, one end of which is closed. The

cylindrical member has a ring-shaped rib 5a" at the upper edge thereof and a slightly curved bottom portion. The grout can 5" is provided with grout hose fitting pipes (outer diameter: 19 mm) 5b" and 5e, and grout hoses 6 are  
5 connected thereto. The pipe 5b" is for grout discharge. The pipe 5e is for grout injection.

The cylindrical inner diameter of the upper edge of the grout can 5" is 108 mm. The height of the grout can 5" is 150 mm. The rib width is 24 mm. The grout can 5" was  
10 made of an acrylic resin.

As shown in Fig. 3, grout G is introduced into the grout can 5" through the grout injection pipe 5e to fill the grout can 5". At this time, additional grouting is carried out satisfactorily so that no void portion will be  
15 left inside the grout can 5". Excess grout is discharged to the outside through the grout discharge pipe 5b".

It should be noted that if there is some fear of the presence of a void continuously extending to the inside of the structure along the tendon member, a hole is bored in  
20 the grout can, and a fiberscope or the like is inserted into the grout can through the hole, thereby allowing investigation of the void.

#### Industrial Applicability:

25 As has been stated above, according to the present invention, the grout can is made of a transparent material. Therefore, during the construction of a tensioned end of a prestressed-concrete structure, the filling condition of

grout in the grout can can be visually observed easily from the outside and grasped reliably.

If the material constituting the grout can is a transparent and electrically insulating material, no  
5 electric potential difference is produced between the grout can and the prestressing steel or other different kind of metal, which would otherwise occur due to water present in a void or the like that is not visually observable. Consequently, there is no danger of the  
10 prestressing steel being corroded by a corrosive electric current as in the prior art.

Further, the grout can is formed in the shape of a half-cut hollow spherical member or a cylindrical member, one end of which is closed, and which has a half-cut  
15 hollow spherical portion at the bottom thereof, whereby it is possible to prevent deformation of the grout can and leakage of grout during grouting at high pressure. In the case of internal cable construction, if the outer surface of the grout can is processed into an uneven surface in  
20 advance, the adhesion of the grout can to post-placed concrete becomes good.

Further, in the case of using a grout can made of a transparent resin, even if it is relatively large in size, the grout can is easy to handle because it is light in  
25 weight.

It should be noted that it was possible to fill the grout completely in the examples using transparent grout cans. However, even if a void is present in the grout can

for some reason after the grout has hardened in an external cable system, the void can be visually recognized easily from the outside of the grout can. Therefore, repair can be executed by boring grout injection and  
5 discharge openings in the grout can and refilling the grout into the void.